MODIS
SCIENCE DATA SUPPORT TEAM
PRESENTATION

September 4, 1992

AGENDA

Page

ACTION ITEMS:

04/24/92 [Lloyd Carpenter & Team] Develop a staffing plan for the accomplishment of the tasks shown on the schedule. (A draft version of the staffing plan has been developed and delivered.) STATUS: Open. Due Date: 06/12/92

06/12/92 [Tom Goff] Develop separate detailed schedules using Microsoft Project for Level-1A and -1B software design and development. (Updated results were included in the handout and presented at the meeting on July 24, 1992.) STATUS: Open. Due Date: 07/10/92

07/31/92 [Ed Masuoka] Implement SLIP on the Sun 670. STATUS: Open. Due Date: 08/28/92

07/31/92 [Tom Goff, Ed Masuoka, Al Fleig] Develop the purpose and requirements for a packet simulator. Get more information on the packet simulator being developed by SBRC. (An updated draft requirements specification is included in the handout. Ed or Al to check on the SBRC packet simulator. See if it will meet our needs, and if/when it will be available to the SDST.) STATUS: Open. Due Date: 09/04/92

08/21/92 [Paul Hubanks] Check to see what existing geolocation and pixel navigation software is available, and what EOSDIS plans to provide. (A report is included in the handout.) STATUS: Open. Due Date: 09/04/92

MODIS Airborne Simulator (MAS) Status

Liam E. Gumley
Progress up to 3 September 1992

(1) MAS data processing

Most of this week was spent processing the dataset from the ASTEX flight on 17 June 1992. This was identified by Mike King as a high priority dataset, and he asked that it be processed as soon as possible. The data tape was received from Ames on Monday, and was read and decoded on the ltpindigo machine. The decoding program now strips the INS navigation data into a separate file as it decodes the MAS data to Intermediate format. I then selected 15 straight line flight tracks based on the INS roll versus time. On Tuesday I spent time setting up the instrument configuration file including the ASTEX spectral response functions. I also modified the navigation code to read the Exabyte format navigation data. On Wednesday I received the preliminary ASTEX calibration coefficients from Tom Arnold, and processed the 15 flight lines on ltpindigo. An Exabyte 8500 tape copy was produced and taken to Code 913. After some investigation it was found that they did not seem to have an Exabyte 8500 connected to any of their computer systems, however they did have some Exabyte 8200 drives. On Thursday I recopied the output tape to Exabyte 8200 format and delivered it to Tom Arnold.

I also created quicklook GIF images for all of these flight lines and transferred them to ltpiris2 where they can be retrieved by anonymous FTP. I have notified all in Mike King's group where they can get GIF viewers for their Macs, and most of them have the viewers running.

Tom Arnold notified me that the coefficients he gave me for the visible/near-IR channels during FIRE are wrong. A gain setting was neglected in the generation of the temperature sensitivity coefficients, and these numbers need to be recomputed. This means that the FIRE dataset processed at this stage (14-NOV-91) will need to be re-processed.

(1) MAS data processing software development

In response to a request from Si-Chee Tsay I wrote a brief (50 line) Fortran program that demonstrates how to retrieve radiance values from a MAS netCDF flight line file. The program gets the radiance data for a specified record, channel and pixel, scales it appropriately using the scaling factor attribute stored in the file, and then prints it along with the appropriate units which are also stored in the file. This program was emailed to Si-Chee on Thursday.

DRAFT

MODIS Level-2 Processing Shell Design and Development

J. J. Pan
Research and Data Systems Corp.
(301) 982-3700

Date: August 31 - September 4, 1992

1. **Algorithm Dependency Diagram**

A list of required instruments for the input data in the MODIS Level-2 processing and the affected MODIS algorithms is attached. The instruments are grouped into EOS and NON-EOS. Before Launch (BL) and correlative data requirements are not included in the list. PL means Post Launch, otherwise, the data is At Launch (AL).

Currently Lloyd Carpenter and I are checking the data type. We will provide an updated diagram in which algorithms are classified into AL or PL. Here are some preliminary results we have found :

In Part1:

The Incident Par Algorithm (558) cannot run if Wind Speed (Data 1735) is not selected from ALT.

In Part 2:

The Glint Field, product number 2254, generated by Algorithm 511, may either be considered as a required separate product or be taken into account internally in computing the other ocean products which are dependent on the glint field.

In Part 3A:

The Cloud Effective Emissivity Algorithm (533), the Dissolved Organic Matter Algorithm (515), and the Pigment Concentration Algorithm (557), depend on the Post Launch product number 1332 from AIRS, which is not selected.

The Spectral Surface Reflectance Algorithm (540), is scheduled for Post Launch, but it's products are required as input to the At Launch Algorithm 536.

In Part 3B:

The Water Vapor Algorithm (513) depends on the surface temperature product (2523) from AIRS, which is Post Launch, selected.

The Aerosol Optical Depth Algorithm (524) and the Aerosol Single Scattering Albedo Algorithm (527) depend on the aerosol phase function product (2335) from MISR, which is Post Launch , selected.

The Directional Reflectance Algorithm (518) depends on the cloud cover product 2088 from CERES, which is At Launch, not selected.

The Bidirectional Reflectance products 2424 and 2425, and the Aerosol Single Scattering Albedo product 2003, must be generated At Launch in order for the Aerosol Optical Depth Algorithm (524) to run At Launch.

<u>In Part 4:</u>

The Post Launch products 191, 32, and 2846 must be generated At Launch in order for algorithms 543, 559 and 808 to run At Launch.

Instruments Required for Input Data in the MODIS Level-2 Processing

	Instrument	Input data used in the Level-2 Processing	Affected MODIS Algorithm
EOS :			
	AIRS/AMSU	1332 (PL)	515, 533, 557
		1588	513, 523, 528, 530, 533, 534
		1828	526, 528, 530, 533, 534
		2481	513
		2523 (PL)	513
	ALT	1735	515, 547, 557, 558
	AMSU-A	**2350**	538
	ASTER	**2828**	518, 520, 807, 808
	CERES	2088	518
	HIRIS	2653	520
	MHS	**2352**	538
	MIMR	**3594**	515, 547, 558
	MISR	**2335** (PL)	524, 527
		2631	806
		2632	806
		2846 (PL)	808
	STIKSCAT	**1680**	515, 547, 557, 558
NON-EOS:			
	ATSR	191 (PL)	543
	MMR	203	541
	POLDER	7001 (?)	519
		7002 (?)	519
	SeaWiFs	32 (BL, PL)	512, 559

1. Before Launch (BL) and correlative data requirements are not included.
2. Selected data products are in boldface.
3. PL means Post Launch.

Issue: MODIS **Glint Field** products 1688 and 2254 (algorithm 511; Gordon) were not selected for at-launch product generation. The selected **Water-Leaving Radiance** products 2416 and 2417 (algorithm 545; Gordon et al.) require **Glint Field** product 2254. Water-leaving radiances are the essential first step in producing all quantitative bio-optical ocean data products. Two possibilities arise:

1. <u>Produce water-leaving radiances, but do not apply a correction for sunglint</u>. This is the procedure that was applied for Nimbus-7 CZCS processing (sunglint-contaminated areas were masked out during quality control). Chuck McClain (971) stated recently that sunglint contamination would also be masked out as a part of SeaWiFS processing (Watson Gregg, 902, personal communication, September 3). A MODIS bio-optical ocean algorithms, including atmospheric/glint correction, will be based on SeaWiFS algorithms. However, the launch of SeaWiFS precedes that of MODIS on the AM spacecraft by some 5 years. Likely, a sunglint correction will be implemented by that time, and is a part of the execution phase proposal of Howard Gordon.

2. <u>Incorporate sunglint correction into water-leaving radiance algorithm/produce glint field as interim product only.</u> The rationale for inclusion of a sunglint correction into the MODIS ocean discipline higher-level processing should be based on scientific considerations—are the water-leaving radiances significantly improved with sunglint correction? This is an issue for MODIS algorithm peer review and should not be determined at this time. Fields of radiances due solely to sunglint will be of limited use to most EOS investigators outside the MODIS science team. However, the sunglint correction, produced solely from fields of near-surface winds, can be applied as a part of water-leaving radiance correction without creating a stand-alone scientific product.

CONTRADICTIONS IN DATA DEPENDENCIES FOR NEWLY SELECTED MODIS PRODUCTS

Philip Ardanuy, Research and Data Systems, (301) 982-3714, September 3, 1992

ISSUE 1: DELETION OF MODIS GLINT FIELD PRODUCTS

MODIS **Glint Field** products 1688 and 2254 (algorithm 511; Gordon) were not selected for at-launch product generation. The selected **Water-Leaving Radiance** products 2416 and 2417 (algorithm 545; Gordon et al.) require **Glint Field** product 2254. Water-leaving radiances are the essential first step in producing all quantitative bio-optical ocean data products. Two possibilities arise:

1. Produce water-leaving radiances, but do not apply a correction for sunglint. This is the procedure that was applied for Nimbus-7 CZCS processing (sunglint-contaminated areas were masked out during quality control). Chuck McClain (971) stated recently that sunglint contamination would also be masked out as a part of SeaWiFS processing (Watson Gregg, personal communication, September 3). A MODIS bio-optical ocean algorithms, including atmospheric/glint correction, will be based on SeaWiFS algorithms. However, the launch of SeaWiFS precedes that of MODIS on the AM spacecraft by some 5 years. Likely, a sunglint correction will be implemented by that time, and is a part of the execution phase proposal of Howard Gordon.

2. Incorporate sunglint correction into water-leaving radiance algorithm/produce glint field as interim product only. The rationale for inclusion of a sunglint correction into the MODIS ocean discipline higher-level processing should be based on scientific considerations—are the water-leaving radiances significantly improved with sunglint correction? This is an issue for MODIS algorithm peer review and should not be determined at this time. Fields of radiances due solely to sunglint will be of limited use to most EOS investigators outside the MODIS science team. However, the sunglint correction, produced solely from fields of near-surface winds, can be applied as a part of water-leaving radiance correction without creating a stand-alone scientific product.

ISSUE 2: DELETION OF MODIS WATER VAPOR AND AEROSOL SINGLE SCATTERING ALBEDO PRODUCTS

MODIS **Water Vapor** products 1874, 3321, and 3322 (algorithm 513; Kaufman and Tanre) and **Aerosol Single Scattering Albedo** product 2003 (algorithm 527, Kaufman) were not selected for at-launch product generation. The selected **Aerosol Optical Depth** product 2294 (ocean only) and the deselected product 2293 (land only) (algorithm 524; Kaufman and Tanre) require **Glint Field** product these as ancillary data. There are two additional complications:

1. Water vapor product 1874 is valid over land only (even if it had been selected), and thus would have been valid to correct product 2293 (which was not selected) but not the selected product 2294 for oceans. In fact, <u>some</u> source of water vapor is required to be able to generate this product, yet all relevant MODIS products were not selected.

2. The only other MODIS water vapor product, **Total Precipitable Water** (product 1875, algorithm 530, Menzel), was also not selected for production. As a consequence neither the MODIS thermal-IR global night/day algorithm or the day-only higher-resolution near-IR algorithm water vapor/total precipitable water has been selected. As it stands, <u>the current plan eliminates any MODIS contribution towards meeting science priorities in a very important area—the water/hydrological cycle</u>, and makes impossible Yoram Kaufman's planned simultaneous analysis of water vapor, clouds, and aerosols.

ISSUE 3: DELETION OF MODIS TOTAL COLUMN OZONE AND PRECIPITABLE WATER PRODUCTS

The MODIS **Total Column Ozone** products 1333 and 1334 (algorithm 523, Menzel) was not selected. As a result, it is presently impossible to produce **Spectral Surface Reflectance** products 2015 and 2016 (algorithm 540, Kaufman and Tanre), **Dissolved Organic Matter** products (algorithm 515, Carder), **Pigment Concentration** products (algorithm 557, Gordon and Clark), and **Aerosol Optical Depth** products (algorithm 524, Kaufman and Tanre). All of these products require total column ozone as a part of their atmospheric correction. The ozone may be obtained from MODIS, AIRS (when launched), TOMS (if available), or any TBD other source. There is a general requirement for total column ozone for all MODIS atmospheric corrections over land and ocean. MODIS-derived ozone is by far the most convenient, being in the same scan coordinate system, while TOMS-derived ozone may be the most accurate. Over land, satellite-derived ozone is desirable, but not essential (climatology could be used with some limited degradation in quality).

Two selected products, **Cloud Droplet Effective Radius** and **Cloud Optical Thickness** (algorithm 536, King) required data from the selected **Spectral Surface Reflectance** product (algorithm 540, Kaufman and Tanre), which depends on two deselected products. These are MODIS **Total Precipitable Water** product 1875 (algorithm 530, Menzel) and **Total Column Ozone** products 1333 and 1334 (algorithm 523, Menzel). Mike King verifies (personal communication, September 3) that these dependencies in fact exist. The present-day algorithm incorporates an assumption for surface reflectance (over ocean only). Extension to global retrieval on MODIS requires knowledge of spectral surface reflectance—a version of the cloud optical thickness algorithm will be run at launch. King and Kaufman both agree that the spectral surface reflectance algorithm must take into account viewing geometry (due to non-Lambertian surfaces). As a consequence, the data will be produced for perhaps 16, 16/2, 16/3 different orbit sets (the 233 orbits repeat every 16 days, but exact repetition is not necessary), for cloud-free areas only. The data set will be updated dynamically for use with the cloud optical depth algorithm.

Spectral Surface Reflectance is defined as a Post-Launch (PL) product, while **Cloud Optical Thickness** is defined as an At-Launch (AL) product. This would appear to be a problem as an AL product would require ancillary information from a PL product for generation. However, Yoram Kaufman (personal communication, September 3) envisions several versions of **Spectral Surface Reflectance**, and the atmospheric correction associated with it. One might be available AL, and would include corrections for gaseous absorption/scattering only. A second might be available PL, and would additionally incorporate treatment of aerosols. The latter are too complex to validate for the MODIS bands prior to launch (Yoram Kaufman, personal communication, September 3). A third variant would include atmospheric correction only to cloud level, to be compatible with assumptions in the cloud optical depth algorithm.

MODIS Items of Interest

from the

EOS-AM-1Operations Meeting

27-28 August, 1992

Thomas E. Goff
NASA/GSFC/MODIS/SDST/RDC

Data Set Delivery Interval- The TDRS Onboard Navigation system (TONS) designers are recommending two 5 minute contacts per orbit to provide the optimum contact interval for the onboard Kalman filtering techniques to be used. This suggests a two per orbit data set interval could be provided to EDOS. In addition, John Barker is requesting two data sets per orbit for his purposes. [This may have implications for the Level-1 processing.]

No provision for the 6 month EOS-AM1 and EOS-AM2 overlap is currently being considered. Data is currently planned to be available from either, not both sources simultaneously.

TDRS Capacity - The currently planned launch interval for the TDRS and TDRS-II satellites can handle the data rate for the EOS-AM1 satellite only after 1999. During 1998, only 59 to 81% of the data requirements can be met. This assumes a single 30 minute contact per orbit. These numbers increase to 79 to 98% for two 15 minute contacts per orbit. (Other assumptions apply.)

Navigation Accuracy - Good News -> TONS is expected to provide significantly better than 100 meter positional accuracy in real-time onboard the satellite. Simulations and data from the EUVE-EV (sp?) TONS system are approaching 20 meter accuracy after several initial contacts and if two contacts per orbit are accomplished. Attitude accuracies (with modelable errors removed) approach the best available ground based methods with errors in the 8 to 11 arc second range. These accuracies are driven by the Earth gravitational model which will be improved shortly. The above errors represent accuracies of the TONS navigation system and do not include spacecraft to MODIS offsets, thermal deformations, or uncompensated dynamic moments from the various spacecraft instruments.

Bad News -> TONS likes to see a good, unobstructed, Doppler signal which means a 90 degree (according to the TONS presentation) angular position to TDRS. Also, the single EOS-AM1 antennae may be in the EOS satellite shadow which will not allow the necessary TDRS contact. This is a function of the antennae tower height.

No post processing of the spacecraft ephemera will be performed.

Quick Look Processing - Instrument commands will be uploaded to the platform once per orbit during the TDRS contact. The quick look flag can only be set up to 5 minutes (EDOS) before that time. Instrument data will normally be recorded on the high speed satellite recorders which will be rewound before transmission to the TDRS. EDOS will provide rate buffered data with only a 5 minute delay. This applies to both the quick look and normal data flow. Data will be routed, not duplicately routed, by the single application ID and quick look flag in the CCSDS packed. This means that quick look data will not be included in the normal data set.

Flight Operations Segment (FOS) says commands should be submitted 2 days in advance and checked for consistency by instrument teams, not FOS. This could produce problems in instrument data rate versus the tape recorded speed. The delays in commanding also apply to the quick look flag.

The comment was made that direct broadcast will include ancillary data but quick look will not. How does the S/C know if quick look data is coming from the instrument?

Test Data Availability - At launch minus 13 months, GE will provide science data from the EOS-AM1 as a part of the integration testing. This will be available on tape, not through electronic means.

Level-0 Packets - EDOS says the Level-0 packets will be padded to the proper length provided that a valid application ID can be found. Reed-Solomon will correct data to 1 bit error in 10 to the 12 bits. An EDOS PDS specification document contains the Level-0 accounting (metadata) information.

Packet Simulation - Flight Ops says they will do a telemetry simulation. I don't know if this will be to the packet level or what it will encompass.

Miscellaneous

The direct broadcast X-band capability is being looked into by Wallops. This may allow real-time data to be transmitted to the DAACs. The telemetry format has not been looked into: i.e. TDM, packets, etc.

Each instrument can now have 32 APID's, more if requested.

A data dictionary for the entire data system will be available in October.

MODIS needs an operational scenario for operation during S/C maneuvers.

Instrument modes need to be coordinated with S/C modes.

MODIS SRCA is an additional uncompensated momentum source.

MODIS Level-0 Packet Simulator
First Release
Requirements Specification
Second Review Draft

NASA/GSFC/MODIS/SDST/RDC
Thomas E. Goff
3 September, 1992

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Background - This document contains the requirements and specifications for a proposed software program that will generate simulated MODIS instrument telemetry packets to be used as input test data for the MODIS Level-1A Data Product Generator program. This product generator program will be a part of the EOSDIS Product Generation System (PGS) contained within the EOS Core System (ECS). This proposed software program reflects the needs of the MODIS Science Data Support Team which has been tasked with the creation of the MODIS Level-1 through Level-2 data product generation program executions.

The initial version (first release) of this simulation program will generate simulated Level-0 packets representing the proposed format of the instrument data packets to be generated by the MODIS instrument. This initial release of the program will simulate the packet data representation with no provision for including a science component. It will be used to exercise and test the programming logic of the MODIS Level-1A Data Product generation program to be written by the MODIS SDST staff. The requirements listed in this document are designed to exercise all possible problems that might occur within the instrument and telemetry stream, in addition to the normal expected packet contents and sequences.

This simulator is designed to produce the Level-0 packets and place them, one packet pet record, into a user designated disc file. The generation of packets at the MODIS instrument data rates will *not* be attempted with this simulator. The EOSDIS concept includes a facility for staging the Level-0 data instrument packets, external to the Level-1A Data Product generation program, thereby negating any requirement for a real-time packet generation simulator at this time. In addition, preliminary performance profiling will be determined on the Level-1A Data Product generator, not on the Level-0 packet simulator.

A design goal for this simulator will be to create a program that can be easily modified for packet content changes and will exercise all imaginable problems with the telemetry bits. An additional simulator, as either a continuation of this effort or a separate effort, that will generate packets with actual or synthesized science content for end-to-end testing may be envisioned for the future.

Several companion programs will be necessary to completely test and validate the MODIS Level-1A Data Product Generation program and are *not* a part of this effort. This simulator will *not* be used to generate the Level-0 metadata (EDOS Level-0 accounting data) or any of the Product Generation System (PGS) scheduler messages which are further required inputs to the Level-1A

Data Product Generation program. If the requirement for navigating the MODIS science data is placed upon the Level-1A Data Product Generator, a separate program that will produce the spacecraft position and attitude data set will be required. A separate Level-1A Data Product Validation program will also be required to verify the contents of the generated Level-1A output scan cubes. Specifications for these companion programs will be contained within separate development efforts and corresponding requirements documents.

General Information- This simulator will be written as two separate entities: a user input portion and the packet generation portion. This will allow the user interface to be changed into an advanced graphics user interface (GUI) as a future enhancement. A data structure, common to both the user sections and the simulator section, will be generated and implemented as an include file that will allow additional simulation requirements to be added in the future. This allows each entity to be considered as a separate object for development purposes. This program will be written in the C programming language with a possible migration to the C++ language in the future.

Specifics - The instrument will generate five types of packets: Calibration, Day, Night, Engineering, and Download. This simulator will generate calibration, day, and night packets in the corresponding appropriate short and long formats at the first release. Engineering and download packets can be added to the simulator at a later release. For each of these packet types, a series of bit field specifications can be applied by the user. These specifications are outlined below.

Specification - The MODIS Level-0 packet simulator will provide the capabilities in the list that follows: (Items that will not be explicitly specified by the user interface to the simulator, and therefore are not a part of this requirement, are enclosed in brackets [].)

This simulator program will manipulate and/or create data in three stages of packet simulation at the first release. The lowest stage will generate data at the bit level that will normally contain the correct bit values, but can be modified by the user to inappropriate values. This stage will generate the base data packets. Note that data packets generated by other sources could be used in place of the synthesized stage one packets but can also be altered at the instrument level with this simulator. The middle stage will allow the generated packets, taken as a bit stream, to be altered in a user specified, pseudo random manner. This will allow the packet contents to be altered at the packet level, not the MODIS instrument level. The top stage will modify the ordering of packets after they have been generated or altered at the earlier stages.

Packets that have been previously generated and are contained within a disc file will have the ability to be modified by altering the packet order and modifying a subset of the instrument bits. Bit level information that pertains to the time codes, scan counter, frame counter, sequence indicator, mirror side indicator, and calibration counters will *not* be alterable after the packets have been generated. A new packet sequence must be generated, or obtained from external sources, for these capabilities.

The requirements for this simulator are driven by the requirements on the Level-1A Data Product Generator program. The reasoning and traceability behind these requirements are also included. They are presented in a top down ordering.

The Level-1A program will have the ability to accept Quick Look data which has been defined as packets that may not necessarily be time ordered or with duplicities removed. Therefore, at the packet storage level, after the packet records have been generated, the following capabilities are required:

The Data Set Level

- The reordering of the packets by user specified packet count range, in either an inverse sequential or locally random order.

- The ability to delete or duplicate a user specified number of packets within the simulated packet sequence.

The Packet Level

The use of a packet telemetry format should preclude the reception of packets that do not match the application ID (APID) or correct length. However, the Level-1A data product generator program will contain the logic necessary to validate the packet format. Therefore, at the packet level, to be applied before any packet reordering, deletion, or duplicating and after the bit level requirements have been met, the following capabilities are required:

- Pseudo random packet length differences at user specified intervals for both long and short packet types. A small number of bits will be added or subtracted to the bit stream at random locations within the bit stream at user specified intervals of the packet sequence.

- User selectable central bit position and neighborhood (surrounding) bits will be able to be: set to 1, set to zero, or altered into a complemented condition.

The Bit Level

The Level-1A data product generator program will have the ability to detect and flag anomalies in the packet data. It will also place the instrument data into output data set fields as determined from the various counters within selected packet fields. Several of these counters will be automatically incremented and are therefore not alterable at this bit level, but can be altered at the packet level. The MODIS instrument bit fields given below follow the current specification for the MODIS data packets.

- The user will be able to select the instrument mode: day or night. (Quick-look requirements are TBD.) This will determine the packet type and length.

- The version number will be nominally fixed at 000, but will be user alterable.

- The CCSDS type will be nominally fixed at the expected default value of 1. It can also be user alterable.

- Secondary header flag will be nominally fixed to a value of 1, user alterable.

- The Application Process Identification will be nominally set to the MODIS ID (TBD). This APID will be user selectable between the three proposed MODIS IDs and any non-MODIS ID.

- The sequence flags will normally be set to the values appropriate to the packet type and segment within the packet. The user will be able to replace these values with a constant value.

- [The sequence count will be incremented for each sequential packet. No user interaction will be required as this can be altered at the packet level.]

- [The packet length will be determined from the packet type. No user interaction will be required as this can be altered at the packet level.]

- The time code will be updated from a user specified starting time and updated according to the frame delay time for each of the data sources starting times. The time code format will follow the spacecraft time code formats and will be automatically clocked per the MODIS design.

- The quick-look flag will be user setable.

- [The packet type will be automatically determined from the user selectable instrument mode. No user interaction will be required as this can be altered at the packet level.]

- [The scan Count and Mirror Side fields will be automatically determined by the simulator.]

- The Source Identification fields will be set to the science frame count for science (Earth scan) data and the (TBD) correct ordering for calibration frames (source, calibration mode, and calibration frame count).

- The Focal Plane Electronics bits will be individually user selectable for power on and select.

- [Each frame of detector or calibration data will be set to all zero's in the initial version of the simulator. A requirement for a user specified science data pattern may be added in the future.]

- Padding bits will be added as necessary to byte align the data.

MODIS Level 1 Navigation and Input Data Simulation

Paul A. Hubanks
04 September 1992

Objective

Locate and test for accuracy and speed any available software that :
1. performs navigation of satellite instrument data.

In addition locate any available software that :
1. models the orbital track of the spacecraft in order to generate files of simulated spacecraft position and attitude, and instrument scan angles (to aid in the testing the navigation software).
2. generates solar ephemeris.

Testing will be done by generating pixel geolocation, along with the spacecraft and solar azimuth and zenith angles with respect to the pixel for controlled cases.

Progress

The following software has been located:

SPACETRK	- NORAD orbital model (Fortran). This uses a 2-line element set to describe the orbital parameters of the satellite.
ORBIT_ST	- Satellite tracking program based in W3IWI classic orbit (Basic).
QUICKSAT	- Satellite prediction program by Mike McCants (?)
SEESAT4	- Earth satellite tracking program (C). Uses the SGP4 prediction model.
SFS101	- Orbital flight simulator. Graphics based, real-time, animated simulator.
SGP_C_2	- SGP satellite orbit prediction model (C).
ALMNAC12	- generates solar and lunar ephemeris for a given earth location and time (BASIC).
AMSAT	- orbital predictor programs.
ORBGEN	- orbital predictor programs from Software Corporation of America.

I also spoke to Fred Nagel (NESDIS at U. of Wis.) on Monday. He is sending me copies of his earth navigation and orbit prediction code on floppy diskette. In addition, Dr. Skip Newhall is sending me information on ordering JPL's DE200/LE200 solar/lunar ephemeris calculator.

I have also begun to generate test cases for the earth navigation software.